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A Discussion of a Popular Soda-Lime Tank Batch

By Irving E. Adams[1]

MOST of the commercial soda-lime tank glasses, aside from window and plate, produced in this country up to very recent times, were made from very simple batches. On a 1000 lb. sand basis, the soda would vary from 360 lbs. to 400 lbs., the lime figured to the burnt product from 90 lbs. to 125 lbs., sometimes with and often without a little salt-cake, and invariably a little arsenious oxide.

Much can be said in favor of these simple mixtures. Their cost is low. Storage, weighing, and mixing present few complications. They have been melted in tanks of varied design, with different fuels, and often by inexpert men and yet made good commercial glass. Bottles of every kind, containers, fruit jars, machine-made tumblers and table-ware, as well as hand-made pressed and blown ware have usually been made from simple formulas. Such formulas are popular even today, and in view of the present necessity of keeping batch costs down, a manufacturer may well hesitate to go to more expensive and complicated batches.

With these simple batches we have done very well indeed. Yet pressure is constantly being brought to bear for more production, more fusibility, and more durability. So under the guidance of competent glass technologists our batches are being gradually modified to include aluminum containing compounds, borax or some allied boron compound, barium in some form, and quite recently ammonium sulphate. There have also appeared on the market from time to time various nostrums under trade names that claim to confer certain special benefits to the melt.

There are real advantages to be derived from recent advances in glass technology. The manufacturer must decide if this new knowledge is vital to his product, and if he can stand the increased batch cost. To help the manufacturer to a decision I propose to discuss in some detail a typical batch of the new order, which, with some slight variations from plant to plant, is in fairly general use today. This batch is given in the next column.

Discussing these various ingredients in the order in which they are written we note that the actual silica content on analysis would be well under 74.00%. We thus gain something from a fusibility standpoint over a high silica batch. Again, and of more import, we would be less likely to experience devitrification accompanied by liberation of silica, which happens sometimes with low flux batches. A relatively low silica is also advantageous as regards scum formation.

Coming now to soda, 380 lbs. is just about the ideal figure. Low soda batches, though economical, lack fusibility, do not yield a soft homogeneous melt, and are more apt to produce cord. It is difficult to hold up edges on pressed articles, hard to blow up shoulders on prescription ware, and increases the tendency to check in fabricating bottles and containers. A low soda batch does not letter nicely. It is better to hold the soda up, and take care of the question of durability in some other manner.

Sand	= 1000	pounds
Soda	= 380	"
Burnt Lime	= 120	"
Feldspar	= 70	"
Borax	= 30	"
Barium Sulphate	= 8	"
Salt-cake	= 5	"
Arsenic	= 2	"
Color		
Cullet		

In certain lines of manufacture an even higher soda content than the one specified is desirable. I have in mind the production of automatic table-ware, especially plates and trays, small prescription bottles, milk bottles by certain equipment, and fruit jars. In these instances, and perhaps others, and assuming that suitable arrangements are made to aid durability, more production can be expected with higher soda.

The combined calcium and magnesium oxides in our batch will show on analysis about 8.20%. This figure will meet the approval of most glass technologists, though manufacturers in certain lines will question this point. Using simple batches automatic-pressed tumblers produced

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in some of our largest plants rarely show as high as 8.00% in these oxides, and in general large illuminating units, gasoline cylinders, thermos bottles, large vases and lamp chimneys, have been produced from relatively low lime batches. The special properties of the type batch we are considering, will, I believe, permit the inclusion of these lines even with the lime specified. Certainly beverage bottles are now being made from our type batch, whereas a few years ago lime percentages well below 8.00% prevailed.

After having experimented with rather high feldspar batches, most manufacturers who use it at all have settled down to 60 lbs. to 70 lbs. per batch. This amount will usually show on analysis about 1.20% aluminum oxide, derived partly of course from corrosion of tank blocks. We use alumina in some form primarily to retard weathering, and it has proven to be a very effective agent. Manufacturers producing thin walled ware where the surface area is relatively large compared to the weight would be wise in incorporating some protective agent in their batch. This is especially true when ware is packed in cartons and stored in damp warehouses. Sufficient protection will usually result when the lime percentage is maintained at 8.20%, a moderate soda content, and alumina amounting to 1.20%.

Relatively thick walled ware such as beverage bottles and carboys hardly require alumina as a protective agent, though feldspar is sometimes used for other reasons. Milk bottles though having a heavy wall are often steamed in small dairies and pit badly unless protected as indicated above. Other valuable properties conveyed to a glass batch through the use of feldspar have been portrayed in numerous articles and will not be touched on here.

So with borax. The use of it in the borosilicate glasses, the lowering of the coefficient of expansion, the enhancement of lustre, etc., are beyond the intent of this paper. Here we are interested solely in the added fusibility gained when we employ it in tank batches. From 25 lbs. to 30 lbs. suffice. More than this amount yields a sloppy glass. The effect, as regards fusibility, is positive. If a manufacturer is melting with a simple batch all the glass his orders call for, he can save the additional cost. If he wants more tonnage of plain glass borax used within the limits specified, will help.

After some disastrous experimentation with excessive amounts of barium compounds, quite a few firms are now using a small quantity, usually from 8 lbs. to 12 lbs. of pure barium sulphate, apparently without disturbing color, and, they claim, with a gain in fusibility.

It would hardly seem necessary to have to use salt cake in a batch containing as many fluxes as our type batch. Certainly the amount necessary to use to keep the melting end free from scum should be less than in the simple batches.

In flint glass batches total arsenic rarely exceeds 2 lbs., otherwise additional color will be necessary. Arsenic steadies color and perhaps to a slight extent, decreases the viscosity of the melt.

For some years now American practice has favored low cullet batches. Very recently, for economic reasons, the tendency has been just the opposite. I am sorry that this has happened. It is true that we have learned how to soften these high cullet batches by proper manipulation of the working end temperature, but the necessity of carrying hot refining ends entails many evils from an operating standpoint.

We have stated that most of the common commercial flint glasses for many years were fabricated from relatively simple batches. In general this was true also of light green and amber batches. We have said that many manufacturers still adhere to this type of batch today. We have noted the fact that more complicated batches involving the use of additional chemicals are now engaging general attention, and we have discussed one such batch in some detail. Let us now see what general observations we can safely make.

The newer batches are more expensive. Even though 20% more glass may be produced from the same unit, if the profit per gross is small, say fifteen cents, the additional glass produced will not compensate for the increased batch cost.

That there is a definite gain in fusibility is unquestioned. If the original batch contained 38 lbs. of soda and no other flux other than a little salt-cake, the newer batch containing the same amount of soda and salt-cake plus feldspar, borax, and a barium compound will melt and plain up at a lower temperature.

The presence of fluxes in addition to soda will favor the solution of silica at high temperatures. This in turn brings the melt to a single composition and density more quickly, and thus decreases the tendency toward cord and scum.

We have said something of durability or resistance toward weathering. It seems sufficient in this summation to again stress the very efficient protection to be derived from the use of feldspar. The value of borax in this connection is doubtful, while barium compounds according to some authorities actually make the glass less resistant.

It seems too early yet to comment intelligently on the effect on tank life of the newer batches. Since the melt is made at lower temperatures we might expect longer life, but it may be that the additional fluxes, either single or combined, will be shown to corrode refractories more than is the case with simple mixtures.

It is sometimes stated by practical factory operations that the newer batches have more "body," that more cut-offs can be made per unit of time; that the glass possesses more "flexibility" and hence checks less readily; that it is easier to maintain constancy of temperature in the feeder boot, etc.

One thing is important and frequently discussed, namely, the effect of borax and feldspar on the setting time of the glass. Probably borax very slightly shortens the setting time whereas feldspar lengthens it. Neither effect can be of great magnitude for when both are added to a single batch in the proportions given in our formula, the glass sets in exactly the same time as before the addition was made.

Charles Francis Adams New Director of General Electric

Charles Francis Adams, Secretary of the Navy in President Hoover's cabinet, was elected a director of the General Electric Company at the annual meeting of the stockholders, in Schenectady on April 18. The other directors were re-elected. Owen D. Young, chairman of the board, presided.

Testing Photographic Lenses

By H. W. LEE [1]

BEFORE the Optician makes a lens out of a piece of glass he has to be sure of the stability of his material. In special cases he may have to use glass of doubtful stability, in order to take advantage of particularly favorable optical properties; in such cases the doubtful glass has to be protected by placing it between glasses whose behavior is beyond suspicion, so as to remove it altogether from the reach of atmospheric corrosion. The front glass of the system should be of particularly stable glass, as it is exposed more than the others to mechanical and chemical contacts. The optician has to rely on tests made by the glass manufacturer or in some national laboratory, for quantitative estimations of glass permanency, but he often makes qualitative tests by exposing a polished surface to the atmosphere for a few weeks or months, and observing the behavior. He may sometimes improve the stability by treatment after polishing, e.g. it has been found that by alternately drying and subjecting to moisture a few times (always finishing up by drying) that the permanency of the surface can be greatly improved.

Each batch of glass has to be further examined before being made into lenses. The defects likely to occur in optical glass are (1) the presence of extraneous matter, including bubbles; (2) strain; (3) striae.

The glass manufacturer has greatly improved his technique since the war, so that it is no longer necessary for the optician to apologize for the presence of bubbles in his lenses. Extraneous matter also is now rarely met with, since improved glass making pots have been introduced. When present these defects can be seen when the glass is polished, by direct observation. Rough glass in the form of moldings is coated with a liquid of approximately the same index of refraction, which renders it sufficiently translucent for the detection of serious defects.

Strain, due to faulty annealing is detected by observation with polarized light. Light reflected from a pile of glass plates at an angle of 57° is almost completely polarized. The specimen is held in the reflected beam (Fig. 1) and observed through a nicol prism, as the prism is rotated the field of vision should darken regularly all over and become completely black, if there is no strain in the glass. Strain is shown by the field becoming patchy and never becoming completely black. Moldings etc. again, are coated with liquid of the same index.

Striae, veins, want of homogeneity, etc. are easily seen by the trained eye; they can be rendered more apparent by the arrangement shown in Fig. 2. Light from the lamp L is focused by the condenser A on the lens B, which forms an image of A on the screen S. The specimen is placed close to B. Any want of homogeneity can well be seen by shadows on the screen. Striae or veins are abrupt changes in refractive index in the material, usually due to imperfect mixing in the pot. It has been found that changes of index amounting to two to four units in the third place of decimals may occur.

In general, photographic lenses are used with the object a considerable distance away (usually not less than ten times the focal length away). We can obviously test the optical performance either at the far conjugate point or at the near conjugate. In the latter

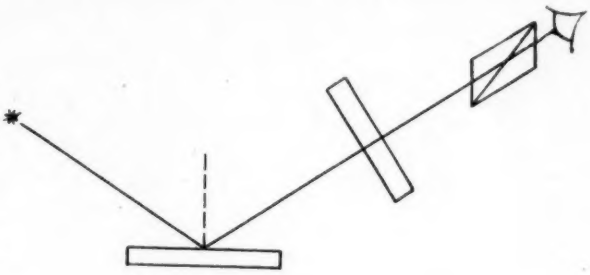


FIG. 1

case the object is set up at a distance at least ten times the focal length from the lens and the image examined with a magnifying glass or microscope. This is obviously all that is needed to show whether the lens fulfills its purpose well, or not, except that, the lens being photographic, a photograph should be taken and examined in a similar way.

The lens designer or manufacturer however, has to observe lenses before they are brought to a state of satisfactory performance, and detect from that examination any errors of design or manufacture. For this purpose he uses as test objects small round apertures or fine lines illuminated from behind. Under high magnification the image of a round hole formed by even the best of lenses is never a perfectly uniform disc of light. Apart from diffraction defects (due to the bending of the light round an obstacle) the image will usually show at least some aberration. When the small hole is on the axis the image can be affected by chromatic and spherical aberrations. Chromatic aberration arises from the fact that white light is composite—a mixture of the various spectrum colors. An uncorrected lens will have different focal lengths for these different constituent colors, as glass bends the different colors different amounts, e.g. blue more than red. The image formed by an uncorrected lens will thus show overlapping discs of different colors, the appearance being that of a white disc surrounded by colored fringes. The optician usually combines two of the images when he "achromatizes" his system. The state of achromatization can be tested in two ways. A direct vision spectrograph can be placed close to the image—this will draw it out into a spectrum. It is then easy to observe which colors have the same focus. Fig. 3a shows the appearance in the eyepiece of the observing system, except for the color of course. The second method is quantitative and consists in measuring the position of the focus for each color: for this purpose the spectrograph is placed in front

[1] Messrs. Taylor, Taylor & Hobson, Ltd., Leicester, England.

of the object slit or hole, which is then illuminated by each different color in turn.

The effect of chromatic aberration can be eliminated by restricting the illumination to light of a single color, so that the lens can be examined for spherical aberration. This defect arises from the different parts of the lens focusing in different planes. Fig. 4 and 5 exhibits this defect in graphical form, horizontal distances indicating "aberration" this, the optician aims at making as small as possible. A microscope is used for examining the image formed by the lens; the optician can tell from the appearance of the image the state of correction of the lens and the seriousness of the outstanding aberration. He can also measure the amount of the aberration by limiting the illumination to a single zone of the lens, and thus measuring the focal deviation of each zone in turn.

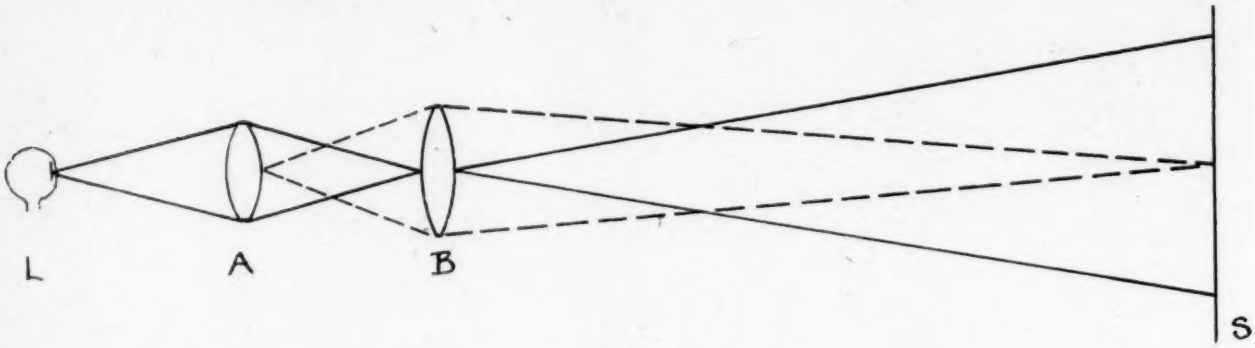


FIG. 2

from the focus formed by the central part of the lens, of the focus formed by a small pencil of rays at incident on the lens at a height corresponding to the vertical distances

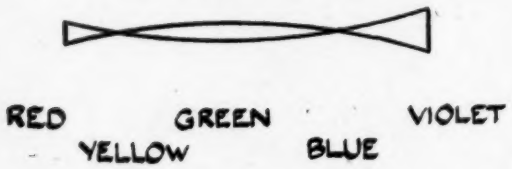


FIG. 3A

in the graph. The optician aims at minimizing this defect by making rays near the edge focus close to the focus

To test the imagery of points off the axis either the object is moved, and with it the observing microscope, or, what is more usually done, the lens is rotated. Use is made of the property of the nodal points of the system, that rays directed to one nodal point emerge in a parallel direction through the other. In Fig. 6 light from a distant point is supposed to fall on the lens. It is brought to a focus at F. If now the lens is swung about its rear nodal point N_2 a ray PQ directed to the front nodal point N_1 will emerge in a parallel direction through N_2 i.e. along the axis RF; and the whole beam of rays parallel to PQ will (in the absence of aberration) be brought to a focus at F′′, where F′F′′ is perpendicular to the new position of the optical

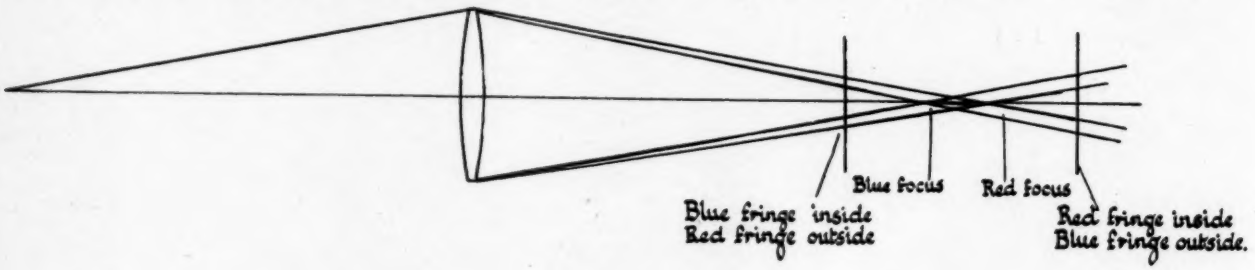


FIG. 3
Chromatic Aberration

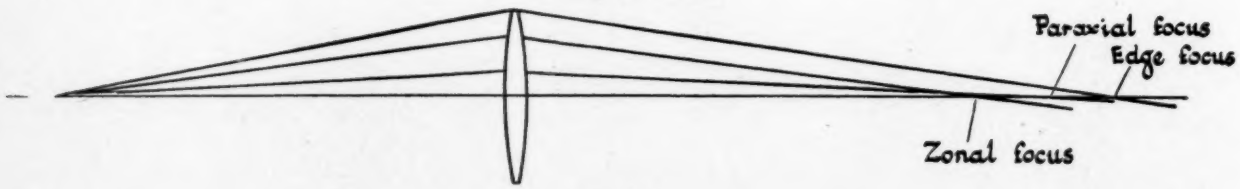


FIG. 4
Spherical Aberration.

formed by the central part of the lens. The outstanding aberration, due to rays from intermediate zones not focusing in the same place, is known as zonal spherical aberration; axis N_1N_2, and $N_2F' = NE$. If the object is a bright circular aperture the image will be circular and in focus at F′′, in the absence of aberration. If the image is not

circular but unsymmetrical, coma is indicated, while if the image is symmetrical but elliptical the defect is astigmatism if the image does not focus at F'' the field is not flat, i.e. a flat object will not be imaged on a flat photographic plate; finally if the image does not remain on the axis as the angle of rotation is increased, the aberration is called

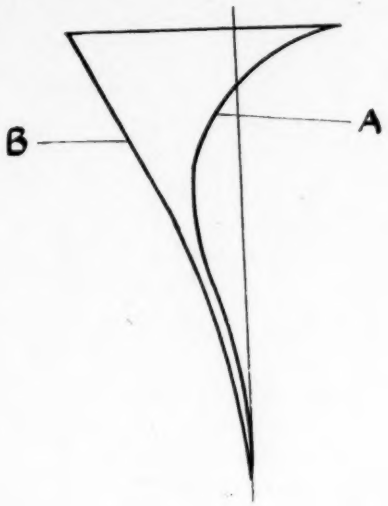


FIG. 5
Graphical Representation of Spherical Aberration.
B. Uncorrected Spherical Aberration.
A. "Corrected" Spherical Aberration, Showing Zonal Aberration.

distortion, and objects will not be represented in correct proportions. It may be added that in order to avoid moving the microscope to keep the image in focus as the lens is rotated, it is usual to move the lens.

In order to save the space required for a distant object it is usual to employ a collimating lens between the object and the lens under test, and the object is placed at the focus of this, so that the collimating lens forms an image of it at an infinitely great distance, and this image is used as the distant object. To avoid moving the microscope to keep the image in focus as the lens is rotated, it is usual to move the lens. This is quite legitimate, as the "object" is a great distance away. To accommodate lenses of different sizes and construction, the lens carrier is made to slide on the rotating holder, so that the centre of rotation may be made to coincide with the nodal point of the lens under test.

The second way of testing the performance of a lens is to examine the image at the long conjugate, e.g. an image of an illuminated object is projected on a distant screen. This furnishes a useful performance test but is not of great use in analyzing aberrations. The distant image may be at infinity, in which case a telescope is used to examine it, and the aberrations can be as readily analyzed as when the microscope is used.

The tests described above have all been visual, but for a photographic lens the final test must be a photographic one. The photographic plate is sensitive to rays which are invisible to the eye, so that it is necessary to test the coincidence of visual and photographic focus. For this purpose the image is accurately focused by means of a microscope, on a plane defined by cross lines or other fiducial marks, and the photographic plate substituted. The object, consisting of ruled lines equally spaced is inclined to the axis of the photographic lens (Fig. 9). If the photographic focus coincides with the visual, the point A focused on will have a sharp image in the photograph; otherwise some other point B will be sharpest. If the ruled lines of the object are all perpendicular to the axis of the lens and to the plane of the paper in the diagram, it is an easy matter to count the number of lines between the sharpest photographic line and the sharpest visual line (the one focused on) to get a measure of the focusing error in the lens.

If there is no error in photographic focus and the lens is satisfactory as regards the aberrations, by visual inspection, a final test is made by taking a photograph of a plane object at right angles to the axis placed at a suitable distance away.

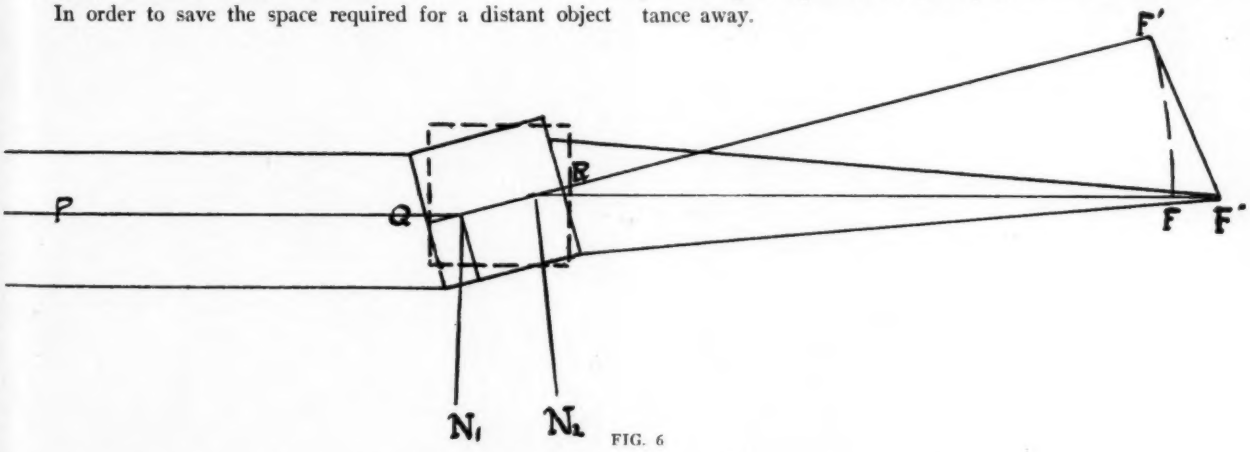


FIG. 6

While every lens issuing from a factory of good repute undergoes tests such as described above, there are some other tests which have to be applied to types only and not to individual lenses. Among these may be mentioned tests for light transmission and for flare. At each glass surface a certain amount (about 5%) of the incident light is reflected and is lost as far as image formation goes, while of the remainder some (usually a negligible fraction) is absorbed by the glass, while some is scattered if the glass is

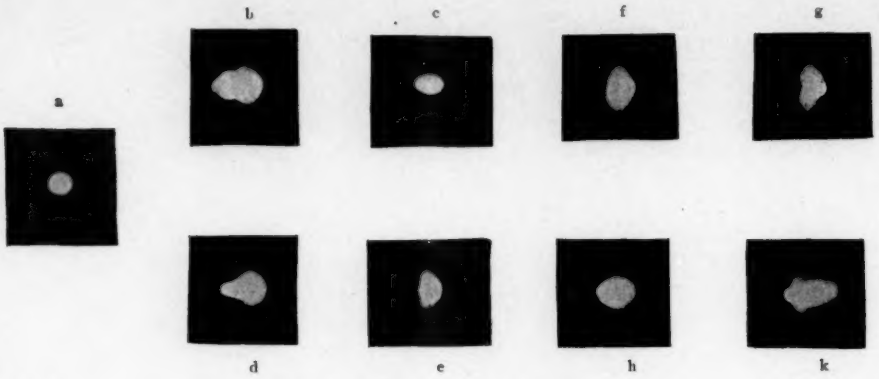


FIG. 7

Photographs of the image of a circular hole formed by some photographic lenses.

a. Axial Image, showing slight spherical aberration.

b. k. Images of hole, off the axis.

c and e show almost pure astigmatism.

h and k show almost pure coma.

b and d show coma and astigmatism combined.

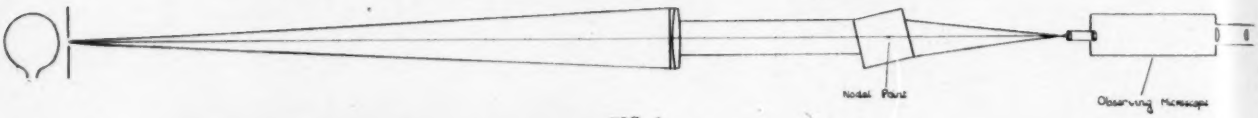


FIG. 8

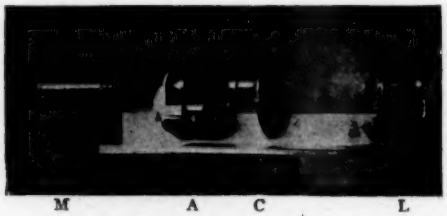


FIG. 8A

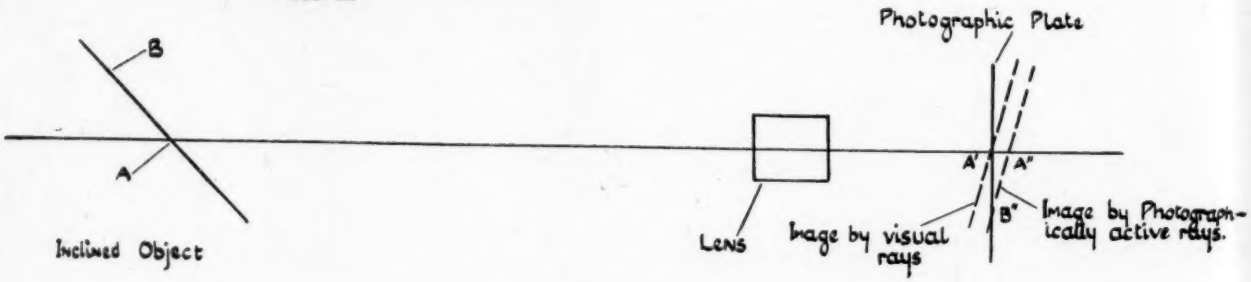
Nodal Slide Bench, Photograph.

L is the lamp, illuminating a small hole.

C is the collimating lens.

A the lens under examination, on the nodal slide.

M the observing microscope.



A' visual image of A

A" photographic image A

B" sharpest point on photographic plate.

FIG. 9

not homogeneous or its surface perfect. The methods of measuring light transmission depend on comparing the brightness of a patch of illuminated screen with and without the interposition of the lens.

Light reflected from an even number of surfaces will travel in the same direction as the image-forming light and will produce a haze over the image plane, or even a pronounced spot. Such "flare spots" or "ghosts" are usually hunted for by photographing a bright source of light against a black background; flare will be at once apparent in the developed negative; its size will vary with the diaphragm aperture. If the flare is too pronounced the design must be overhauled, and a suitably flare-free form evolved.

To test the lens for focal length there are a number of ways mentioned in optical text books and so need not be dealt with here. Aperture is tested by placing an illuminated pin hole in the focal plane and measuring the diameter of the emergent light beam; this divided into the focal length gives the F/number which expresses the speed of the lens.

If the lens is to be used with a focusing scale or mount, the accuracy of this must be checked by placing the inclined object (Fig. 9) at the marked distances and taking photographs.

Errors in adjustment of the lenses in axial alignment are easily detected on the "nodal slide bench" under the microscope, as want of symmetry of the image. On the axis there should be complete symmetry about two lines at right angles so that the image should be circular. When the lens is swung about a line through its nodal point there should still be symmetry about a line at right angles to this and the lens axis.

Tariff Commission Report on Blown Glass Tableware Costs

*Abstracts from Report No. 60, Second Series**

(*Continued from April issue*)

Trend in Methods of Production

A large part of the present domestic and Czechoslovakian production of hand-blown glass tableware is, in general, manufactured by processes differing only slightly from the processes that have been employed for several hundred years. It is believed that the domestic industry has shown greater technical progress than the European industries, particularly in the development of the pressed stem processes and of attractive plate etched designs. It should be noted that the pressed stem processes require a considerably larger investment in molds than is necessary in producing by the drawn and offhand stuck stem processes, and, therefore, the greater investment in pressed stem molds would only be justified by the assurance of comparatively large production and sales. European manufacturers exporting to the United States point out that it would not be economical to invest in pressed stem molds because most of the time they do not have sufficiently large orders for any one article to justify the financial outlay. It requires only approximately 15 minutes to produce a wood mold of the type usually used in Czechoslovakia; and even though this mold must be discarded after the production of approximately 10 dozen articles, there is comparatively little expense involved in its manufacture. In the United States most of the plants have a large amount of money invested in a tremendous variety of iron molds, many of which have been used only for the production of small quantities of specific articles because, among other reasons, the designs may not have proved popular, or the price obtained for the articles did not warrant continued production of them.

In the development of machine processes for the production of blown or partly blown-glass tableware, the United States has made considerably more progress than the rest of the world. Machines for the production of blown or partly blown glassware have been shipped from the United States for use in many countries. Manufacturers in many countries would not be justified in investing in machines for the production of blown or partly blown-glass tableware in that there would not be sufficiently large demand for such ware in their home or in reasonably accessible export markets.

Imports

Official statistics do not clearly indicate the total value of imports of blown glass tableware. Glassware including blown or partly blown in the mold or otherwise table and kitchen articles and utensils, undecorated, colored, cut and engraved, plated or cased glass, blown or partly blown in the mold or otherwise all other, n.e.s.—undecorated, colored, cut or engraved amounted in 1927, $3,719,782; 1928, $3,255,939, 1929, $3,469,145; 1930, $2,249,205 and in 1931, $1,449,130.

Principal Source and Kinds of Imports

Blown-glass tableware is imported into the United States from Czechoslovakia, Germany, England, Sweden, France, Italy, Belgium, the Netherlands, and a number of other countries.

Imports in 1929, and for several years immediately preceding that year, of blown-glass tableware from Czechoslovakia exceeded in quantity and value imports of such ware from any other country, and for the purpose of the investigation Czechoslovakia is the principal competing country.

The great bulk of the imports of hand-blown glass tableware imported from Czechoslovakia is of the following types: Crystal (undecorated); combinations of crystal and color; pantograph etched; full color or color combination; cut crystal; and plated or cased.

Imports of hand-blown glass tableware from Sweden consist principally of cut crystal, although there are imports of crystal and color combinations, crystal with pantograph etching, and full color or color combination ware. The glass composing the better grade Swedish blown-glass tableware is quite similar to that used in the production of the best grade of commercial tableware in the United States (lead-potash glass), in contrast with the potash-soda glass imported from Czechoslovakia.

The imports from England consist for the most part of high-price cut-crystal blown-glass tableware (lead-potash glass), although there are some imports of colored and decorated stem ware. Consumer preference accounts for a large part of the English cut crystal sales in the United States.

Imports from Germany consist largely of colored and plated or cased blown-glass tableware made from potash-soda glass. There is no production in the United States of stem ware similar to the thin-plated or cased ware imported from Germany.

The blown-glass tableware imported from Belgium, France, and Holland is generally much higher in price than that imported from Czechoslovakia and Germany, and to a large extent is confined to cut decorations. Some colored ware, undecorated, has been imported from the Netherlands, and Belgium has supplied a relatively large part of the cased tableware sent to the United States. However, much of this Belgian ware has been restricted to such articles as vases and articles for decoration, such as console sets. A large part of the ware imported from Italy has been confined to Murano or Venetian types.

(*To be continued*)

*Copies of this 60-page report containing numerous tables relating to the production, consumption, costs of blownware and other data may be obtained at 10 cents a copy from the Superintendent of Documents, Washington, D. C.

Chance Brothers and Co., Limited, announce from Birmingham that arrangements have been made whereby in the future there will be very close co-operation between themselves and the Parsons Optical Glass Company. For some time it has been evident that considerable saving in the manufacture of optical glass could be effected by pooling the knowledge of the two firms and by concentrating the production at one establishment. Under this arrangement all optical glass will be made at Chance Brothers Works at Smethwick, Birmingham, England.

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Reference to the contents of earlier issues of THE GLASS INDUSTRY can be found in THE INDUSTRIAL ARTS INDEX in many Public and Technical Libraries.

"Sell American"

The "Buy British" campaign according to a "wireless" to the *New York Times* has proved to be a "flop." At a recent gathering in London of British and American business men, Sir Edward Crowe, Controller of the Department of Overseas Trade and one of the organizers of the movement, which was set on foot by the Empire Marketing Board, of which he is a member, admitted a change of heart on his part as to the wisdom of conducting such a campaign. He said, "We want to buy American goods, and we want the United States to buy ours."

A similar agitation, "Buy American," was begun in this country several months ago. Its most conspicuous promoters included the perhaps not entirely disinterested Hearst newspapers and the *Saturday Evening Post.* So far, however, the country has failed to get excited over the matter. There has been much "tall talk" but so far as the general public is concerned little progress appears to have been made in convincing American citizens that the United States desires to isolate itself commercially from other countries by refraining from using foreign products. A writer in *The Artist and Advertiser,* George H. Corey, past president of the National Industrial Advertisers Association, Cleveland, Ohio, put the case this way:

"One would almost think that foreign products were actually overwhelming the American market, despite the fact that a casual inspection would show that our imports have been steadily diminishing, month by month, during the past three years, and reached their low in September, 1932."

Mr. Corey deprecates the "Buy American" campaign and asks some simple but pertinent questions:

"(1) In October, 1932, General Motors exported 52 per cent of its total production; in November, 59 per cent. Just how can these foreigners pay for these automobiles?

"(2) We buy large quantities of coffee from Brazil. How do we pay for that coffee? In gold?

"(3) We buy large quantities of tea from China and Russia; raw silk from Japan and Switzerland; cotton manufactures from England. Shall we stop drinking tea, use no silk, and completely ruin the market for our southern cotton growers? Or, how do we pay for these goods?

"(4) We produce comparatively little manganese and that of relatively poor quality. Shall we stop importing manganese and throw the entire steel industry into chaos?

"I could go on quite indefinitely, but what's the use? The point is not 'Buy American' but 'Sell American.' And, as a creditor nation, we must come to realize that we have something new to deal with. England was the commercial center of the world under free trade—as long as she was a creditor. When she became a debtor, she erected tariff barriers. And, I might add, despite 'Buy British' campaigns and tariffs, Welsh coal is just as badly off as ever. Despite tariffs, British and German employment has not increased. Despite all the flag-waving that misguided people everywhere do, jobs are not created nor made secure. All that happens is that there is developed a narrow nationalism which, at this moment, is leading inevitably to international hatred and the probability of war."

" 'Sell American.' Then we can buy what we cannot produce, but need—including bananas."

New Commercial Treaty Between Canada and Germany

According to the German-American Commerce Bulletin, the first commercial treaty between Germany and Canada in thirty-five years became effective January 1, this year. Only the Canadian tariff for Empire merchandise grants more extensive privileges than the new treaty with Germany, giving German manufacturers the opportunity of competing in Canada on an even footing with those of practically all other nations. As the United States has no commercial treaty with Canada, German merchandise will have a distinct advantage over United States products. All merchandise from a treaty country must be shipped directly into Canada and cannot be moved through or via any United States port.

March Plate Glass Production

The total production of polished plate glass as compiled by P. A. Hughes, for the member companies of the Plate Glass Manufacturers Association of America for the month of March, 1933, was 4,881,322 sq. ft. as compared to 4,955-293 sq. ft. produced by the same companies in the preceding month, February, 1933, and 4,414,464 sq. ft. produced by the Association members in the corresponding month last year, March, 1932.

Tariff Commission Hearing on Plate Glass

The hearing on the pending investigation by the Tariff Commission on Plate Glass will be held on May 22, 1933.

February Imports and Exports

Imports of glass and glass products during February, 1933, amounted in value to $170,049. For the two months ending February the total imports amounted to $378,415. Cylinder, crown and plain sheet glass, 292,584 pounds, were valued at $13,076; bent, beveled, colored, etc., 64,402 pounds, valued at $5,798; glass mirrors, 24 square feet valued at $56; rolled, cylinder, crown and sheet glass, ground, obscured, bent, beveled, colored, etc., valued at $4,471; laminated glass and manufactures and plated or cased glass $368; bottles, vials, jars and other containers valued $29,555, scientific articles and utensils, $13,695, tubes and rods $3,392, illuminating articles $10,038, blown glass articles—bulbs for electric lamps (no filament) to number 32,700 and value $171; other dutiable blown glassware value $44,660, pressed glass articles, value $4,312, other glassware dutiable $26,535.

Exports of glass and glass products during the month of February were valued at $239,992. For the two months ending February the total exports amounted to $524,149. The February report shows 149,672 square feet of plate glass, unsilvered, valued at $43,097 and 37,384 pounds window and other plate glass valued at $4,255; glass containers, bottles, vials and jars, value, $72,908, table glassware, plain, value $28,809, table and other glassware cut or engraved value $871, lamp chimneys and lantern globes value $2,649, globes and shades for lighting fixtures, $9,298, chemical glassware 10,663 pounds valued at $9,666, glass electric insulators 12,737 pounds, valued at $1,077, other glassware value $67,362.

ASA Initiates Project on Safety Glass

The American Standards Association, through action by its Standards Council, has formally initiated a project for the development of specifications and methods of test for safety glass used in the glazing of windows of automobiles, aircraft, and ships. The project will also cover so-called bullet-proof glass and laminated glass used in industrial goggles.

The initiation of the project was requested by the National Bureau of Casualty and Surety Underwriters and sponsorship has been assigned to the Bureau and the National Bureau of Standards. A sectional committee is now being organized by the sponsors.

In 1906 when the first patents for the manufacture of laminated glass were assigned in this country there were only about 100,000 automobiles on the road. Consequently, there was no automobile accident problem as we know it today to focus attention on glass hazards. It was not until 1927 that automobile manufacturers began to offer safety glass as either standard equipment or optional at a slight extra cost, in order to meet the growing demand for protection from injury due to broken glass.

Some specifications for this type of safety glass have been developed in the United States. The Federal Specifications Board has recently developed specifications for use by the various divisions of the Federal government. The Commonwealth of Massachusetts has a group of specifications to which all laminated glass installed in motor vehicles registered in Massachusetts must conform. Several other states, while not having in effect specifications, have passed laws and regulations requiring the use of laminated glass in certain classes of motor vehicles.

The German national standardizing body, Deutscher Normanausschuss, organized a technical committee about a year and a half ago to develop methods of testing safety glass. Two draft standards have been prepared by the committee. One deals with safety glass for goggles and the other with safety glass for vehicles. The work of the German committee will be made available to the American committee and there will be an interchange of experience and thought as the work of the two committees progresses.—*Industrial Standardization.*

Car Requirements for Glass Containers

According to J. C. Magness, traffic director of the Glass Container Association and as reported by the Atlantic States Shippers Advisory Board on March 30, the estimated requirements for cars for glass containers during the second quarter is 1,950, a decrease of 17 per cent from the actual shipments for the corresponding quarter of 1932, due to less favorable conditions.

March Construction Records Considered Encouraging

Considering the widespread slowing down in business occasioned by the banking holiday the March results in the construction field must be considered encouraging. Normally March shows seasonal expansion in new construction awards; in spite of the banking holiday some seasonal expansion over February occurred. The March contract total of $59,958,500 covering all classes of construction compared with $52,712,300 for February and $112,234,500 for March, 1932, according to F. W. Dodge Corporation.

Current Prices of Glass-Making Materials

April 21, 1933

Quotations furnished by various producers, manufacturers and dealers.

Acid		Carlots	Less Carlots
Citric (dom.)	lb	..	.29
Hydrochloric (HCl) 20° tanks, per 100 lt		..	1.10
Hydrofluoric (HF) 60% (lead carboy)	lt	..	.13½
52% and 48%	lb	.10	.10-.11½
Nitric (HNO_3) 38° carboy ext. Per 100 lt		5.50	..
Sulphuric (H_2SO_4) 66° tank cars	tor	15.50	..
Tartaric	lb	..	.20
Alcohol, denatured	gal	..	..
Aluminum hydrate ($Al(OH)_3$)	lb	.04-.04½	.05½-.06
Aluminum oxide (Al_2O_3)	lb	.07	.09
Ammonium bifluoride (NH_4) FHF	lb		15½
Ammonia water (NH_4OH) 26° drums	lb	..	.02¾
Antimony, metallic (Sb)	lb	02½	03¾
Antimony oxide (Sb_2O_3)	lb	0.7	.07½
Antimony sulphide (Sb_2S_3)	lb	..	.08½
Arsenic trioxide (As_2O_3) (dense white). 99%	lb	.. .04	.14 04½
Barium carbonate ($BaCO_3$), Crude. (Witherite) 90%, 99% through 200 mesh	ton	56.50	..
90% through 100 mesh	ton	44.00	..
Barium hydrate ($Ba(OH)_2$)	lb	..	.05¼
Barium mixture, glassmaker's, f.o.b. St. Louis	ton	25.00	..
Barium nitrate ($Ba(NO_3)_2$)	lb	..	07½
Barium selenite ($BaSeO_3$)	lb	..	..
Barium sulphate, in bags	ton	19.00	24.00
Barium sulphate, glassmaker's, carlots, bulk, f.o.b. shipping point,	ton	15.00-16.00	18.00
Bone ash	carlots, lb	.06	.06
Borax ($Na_2B_4O_7 10H_2O$)	lb	..	..
Granulated	In bags, lb.	.02	.02¼-.02½
Powdered	In bags, lb.	.02¼	.02½-.02¾
Boric acid (H_3BO_3)	In bags, lb.	.04¼	.04½-.04¾
Cadmium sulphide (CdS)— Red	lb	..	.60-.75
Orange	lb	..	.55-.65
Yellow	lb	..	1.30-1.50
Chromium oxide (Cr_2O_3)	lb	.18½	.19
Cobalt oxide (Co_3O_4) In bbls.	lb	..	1.15
In 10 lb. tins	lb	..	1.25
Copper oxide Red (Cu_2O)	lb	..	25
Black (CuO)	lb	..	17-.19
Black prepared	lb	..	.22
Cryolite ($Na_3Al F_6$) Natural Greenland Kryolith)	lb	.08½	.09
Synthetic (Artificial)	lb	..	.08
Epsom salts ($MgSO_4$) (imported) technical	Per 100 lb.	..	1.50-1.75
Feldspar— 40 mesh	tor	11.00	12.00
20 mesh	tor	9.50	..
Granular	ton	9.50-11.00	..
Semi-granular	ton	9.50-11.50	..
Fluorspar (CaF_2) domestic, ground. 96-98% (max SiO_2, 2½%) Bulk, carloads, f.o.b. mines	ton	30.00	..
In bags or barrels	ton	34.00	39.00
Imported	ton	27.00	29.00
Formaldehyde	lb	..	.07
Graphite (C)	lb	..	04-.07
Iron oxide— Red (Fe_2O_3)	lb	..	.0425
Black (FeO)	lb	.04½	..
Kaolin (f.o.b. mine)	ton	8.00-9.00	..
English, lump, f.o.b. New York	ton	14.50-25.00	24.50-30.00

Kryolith (see Cryolite)		Carlots	Less Carlots
Lead chromate ($PbCrO_4$)	lb	..	.30
Lead oxide (Pb_3O_4) (red lead)	lb	.06	.07
Litharge (PbO)	lb	.05	.06
Lime— Hydrated ($Ca(OH)_2$) (in paper sacks)	ton	5.50	..
Burnt (CaO) ground, in bulk	ton	4.00	..
Burnt, ground, in paper sacks	ton	6.00	..
Burnt, ground, in 280 lb. bbls.	Per bbl	2.15	..
Limestone ($CaCO_3$)		1.50-2.50	..
Magnesia (MgO)— Calcined, heavy (in bbls.)	lb	06	07
light (in bbls.)	lb	..	23
extra light (in bbls.)	lb	..	37
Magnesium carbonate ($MgCO_3$)	lb	06	10
Manganese 85% (MnO_2)	lb	57.50	60.00
Nickel oxide (Ni_2O_3), black— for nickel content	lb	..	35
Nickel monoxide (NiO), green— for nickel content	lb	..	.35
Plaster of Paris, bags	ton	21.00	23.00-29.00
Potassium bichromate ($K_2Cr_2O_7$)— Crystals	lb	.07½	.08
Ground	lb	.08	.08½
Potassium carbonate—94-96%	lb	055b	055b
Calcined (K_2CO_3) 96-98%	lb	..	.06¾
Hydrated 80-85%	lb	..	.05¾
Potassium chromate (K_2CrO_4)	lb	..	25
Potassium hydrate (KOH) (caustic potash)	lb	07½	08
Potassium nitrate (KNO_3) (gran.)	lb	..	06-.06¼
Potassium permanganate ($KMnO_4$)	lb	.16	.16½
Powdered blue	lb	..	.17
Rochelle salts, bbls.	lb	..	.11½
Rouge	lb	..	..
Rutile (TiO_2) powdered, 95%	lb	.15-.20	20-.25
Salt cake, glassmakers (Na_2SO_4)	ton	18.00	..
Selenium (Se)	lb	..	1.70
Silver nitrate ($AgNO_3$) (100 oz.)	per oz	..	.20¼
Soda ash (Na_2CO_3) dense, 58%— Bulk, on contract	Flat per 100 lb	1.05	..
In barrels	Per 100 lb	1.38	1.90-2.13
In bags	Per 100 lb	1.17½	1.72½-1.92½
Spot orders.. .025 per 100 lbs. higher		..	..
Sodium bichromate ($Na_2Cr_2O_7$)	lb	.04½	.05
Sodium hydrate (NaOH) (caustic soda) Solid	Per 100 lt	2.50	..
Sodium nitrate ($NaNO_3$)— Refined (gran.) in bbls.	lb	..	3.62
95 per cent	Per 100 lb	1.195-1.295	1.145-1.345
Sodium selenite (Na_2SeO_3)	lb	.	2.00
Sodium fluosilicate (Na_2SiF_6)	lb	.04½	.05-.06
Sodium uranate (Na_2UO_4) Yellow or Orange	lb	..	1.40-1.45
Sulphur (S)— Flowers, in bbls.	Per 100 lb	8.45	8.80-4.00
Flowers, in bags	Per 100 lb	8.10	8.45-3.65
Flour, heavy in bbls.	Per 100 lb	8.85	8.20-3.40
Tin chloride ($SnCl_2$) (crystals)	lb	.27½	.28
Tin oxide (SnO_2) in bbls.	lb	28	29½
Uranium oxide (UO_2) (black, 96% U_3O_8) 100 lb. lots. Black	lb	.	1.35
Yellow orange	lb	..	1.40
Zinc oxide (ZnO)	lb	08½	12
American process. Bags	lb	.05¾	.06
Zircon Granular (Milled .005-.02c higher)		07	07½-.08
Crude, Gran. (Milled .005-.02c higher)		03½	.04-.05

Electrical Device Analyzes Chemicals

An electrical device for analyzing chemicals invented by Professor Jaroslav Heyrovsky of Czechoslovakia, who arrived in New York recently but was immediately sent by the Carnegie Endowment for International Peace, which became intensely interested in the device, to the home of Professor Charles Bernard Lipman at the University of California. The device is called a polarograph. Quick and accurate qualitative and quantitative chemical analysis is its function. It takes only 3 to 5 minutes to determine the nature and constituents of a substance. To do so requires just 2 drops of the solution. The relative amounts of almost identical substances in a mixture can be detected as can also the most minute tracings of poisonous adulterants of alcohol and ether, natural and synthetic vinegar, normal and abnormal urine. Professor Heyrovsky, who has been working on the polarograph for ten years states that it is quicker, more sensitive, more accurate than any other method of analysis. Several universities are already using the device.

An analysis is made by placing a layer of mercury at the bottom of the beaker. This constitutes the anode of a delicately balanced electrical system. The cathode of the system is a column of mercury which flows by separate drops (2 or 3 seconds apart) into the substance to be analyzed. The current which flows through the system increases steadily by definite increments. Substances react in a regular way to the current. By means of a mirror galvanometer, the polarograph marks a chart when reactions occur. Every user of a polarograph furnishes charts of more substances. By comparing the chart of an unknown substance with available polarograph records, the investigator soon solves his analysis problem.

The American Ceramic Society will hold its annual meeting during the week of February 11, 1934, at the Netherland Plaza Hotel, Cincinnati, O.

Engineering Week at Chicago

The week beginning June 25 has been designated "Engineering Week" at the Century of Progress, Chicago's World Fair.

On Wednesday, June 28, sixteen national engineering societies, holding conventions in Chicago that week, will forego separate meetings to participate in one big general program at the Fair grounds.

The Society of Industrial Engineers' convention opens June 27 with an Educational Conference to discuss "The Professional Engineer's Attitude Toward the Curriculum and Graduate in Industrial Engineering." Representatives from thirty or more universities, and many prominent engineers, will attend.

Other subjects to be discussed by S. I. E. are: Recent Social Changes and Their Effect on Economic Life. What Have We Learned of the Art of Management. The Engineer's Part in Economic Stabilization. A Report of an S. I. E. Committee studying Industrial, Economic, and social conditions. Unemployment Insurance. Consumers Acceptance the Hub of Merchandising Plans. Curtailing Sales Expense on Capital Investment Equipment. Use of Micromotion Studies to Reduce Production Costs and Fatigue.

All S. I. E. meetings will be held at Hotel Stevens. Public will be admitted on registering. Programs obtainable from S. I. E. office, 205 W. Wacker Drive, Chicago.

THE GLASS INDUSTRY CLASSIFIED BUYERS' GUIDE

FOR FURTHER INFORMATION, SEE ALPHABETICAL DIRECTORY OF ADVERTISERS AND CONSULT ADVERTISEMENTS

ALUMINUM HYDRATE
Pennsylvania Salt Mfg. Co., Philadelphia, Pa.

ALUMINUM OXIDE
Pennsylvania Salt Mfg. Co., Philadelphia, Pa.

ALUMINUM SULPHATE
Pennsylvania Salt Mfg. Co., Philadelphia, Pa.

ANTIMONY OXIDE
Drakenfeld, B. F., & Co., Inc., New York.

ARSENIC
Drakenfeld, B. F., & Co., Inc., New York.

AUTOMATIC BOTTLE MACHINERY (See Glass Working Machinery)

AUTOMATIC CONVEYORS AND LEHR LOADERS
Amsler-Morton Company, The, Pittsburgh, Pa.
Dixon, H. L., Co., Box 140, Pittsburgh, Pa.
Hartford-Empire Co., Hartford, Conn.

AUTOMATIC GLASS WORKING MACHINERY (See Glass Working Machinery)

AUTOMATIC TEMPERATURE CONTROL
Wilson-Maeulen Pyrometer Division, The Foxboro Co., Foxboro, Mass.

BATCH CARTS
Dixon, H. L., Co., Box 140, Pittsburgh, Pa.

BATCH HANDLING AND MIXING SYSTEMS
Amsler-Morton Company, The, Pittsburgh, Pa.
Dixon, H. L., Co., Box 140, Pittsburgh, Pa.

BLOWERS AND EXHAUSTERS
The Kirk & Blum Mfg. Co., Cincinnati, O.

BLOWER SYSTEMS
The Kirk & Blum Mfg. Co., Cincinnati, O.

BOND CLAY
Amsler-Morton Company, The, Pittsburgh, Pa.
Dixon, H. L., Co., Box 140, Pittsburgh, Pa.
Laclede-Christy Clay Products Co., St. Louis, Mo.
Pittsburgh Plate Glass Co., Refractories Dept., Pittsburgh, Pa.

BORAX
American Potash & Chemical Corp., New York.
Pacific Coast Borax Co., New York.

BORIC ACID
American Potash & Chemical Corp., New York.
Pacific Coast Borax Co., New York.

BOTTLE-MAKING MACHINERY (See Glass Working Machinery)

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Dixon, H. L., Co., Box 140, Pittsburgh, Pa.

CADMIUM SULPHIDES
Drakenfeld, B. F., & Co., Inc., New York.

CASTINGS, GLASSHOUSE
Dixon, H. L., Co., Pittsburgh, Pa.

CEMENT, HIGH TEMPERATURE
Laclede-Christy Clay Products Co., St. Louis, Mo.

CHEMICALS, COLORS, MINERALS, ETC., GLASSMAKERS
American Potash & Chemical Co., New York.
Drakenfeld, B. F., & Co., Inc., New York.
Pacific Coast Borax Co., New York.
Pennsylvania Salt Mfg. Co., Philadelphia, Pa.
Sharp-Schurtz Company, Lancaster, O.
Solvay Sales Corporation, Syracuse, N. Y.

CHEMISTS, CONSULTING
Bailey & Sharp Co., Inc., Hamburg, N. Y.
Preston, F. W., Natl. Bank Bldg., Butler, Pa.
Sharp-Schurtz Company, Lancaster, O.
Solvay Process Co., Syracuse, N. Y.

CHIMNEYS, FACTORY
Amsler-Morton Company, The, Pittsburgh, Pa.
Dixon, H. L., Co., Box 140, Pittsburgh, Pa.

CHROME OXIDE
Drakenfeld, B. F., & Co., Inc., New York.

CLAY For Glassmakers
(See also Bond Clay, Fire and Furnace Clay)
Pittsburgh Plate Glass Co., Refractories Dept., Pittsburgh, Pa.

CLAY POTS
Pittsburgh Plate Glass Co., Refractories Dept., Pittsburgh, Pa.

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COBALT OXIDE
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Preston, F. W., Butler, Pa.
Sharp Schurtz Co., Lancaster, O.

CONTRACTORS
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Amsler-Morton, The, Pittsburgh, Pa.
Dixon, H. L., Co., Box 140, Pittsburgh, Pa.
Toledo Engineering Co., Inc., Toledo, O.

COOLING SYSTEMS
The Kirk & Blum Mfg. Co., Cincinnati, O.

COPPER OXIDE, BLACK
Drakenfeld, B. F., & Co., Inc., New York.

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(Cullet, Coal, etc.)
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CRYOLITE
Natural Greenland
Pennsylvania Salt Mfg. Co., Philadelphia, Pa.

DAMPER, SAND
Dixon, H. L., Co., Box 140, Pittsburgh, Pa.

DECOLORIZERS
Drakenfeld, B. F., & Co., Inc., New York.
Sharp-Schurtz Company, Lancaster, O.

DECORATING MATERIALS AND COLORS
Drakenfeld, B. F., & Co., New York.

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The Kirk & Blum Mfg. Co., Cincinnati, O.

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Dixon, H. L., Co., Box 140, Pittsburgh, Pa.
Fuel and Furnace
Amsler-Morton Company, The, Pittsburgh, Pa
Bailey & Sharp Co., Hamburg, N. Y.
Dixon, H. L., Co., Box 140, Pittsburgh, Pa.
Hartford-Empire Co., Hartford, Conn.
Sharp-Schurtz Company, Lancaster, O.
Toledo Engineering Co., Inc., Toledo, O.
Glass Factory
Amsler-Morton Company, The, Pittsburgh, Pa
Bailey & Sharp Co., Hamburg, N. Y.
Dixon, H. L., Co., Box 140, Pittsburgh, Pa.
Sharp-Schurtz Company, Lancaster, O.
Toledo Engineering Co., Inc., Toledo, O.
Mechanical
Bailey & Sharp Co., Hamburg, N. Y.
Dixon, H. L., Co., Box 140, Pittsburgh, Pa.
Plate Glass Factory
Amsler-Morton Company, The, Pittsburgh, Pa
Dixon, H. L., Co., Box 140, Pittsburgh, Pa.
Producer Gas
Amsler-Morton Company, The, Pittsburgh, Pa.
Dixon, H. L., Co., Box 140, Pittsburgh, Pa.
Wellman Engineering Co., Cleveland, O.

FANS, EXHAUST.
The Kirk & Blum Mfg. Co., Cincinnati, O.

FEEDERS, AUTOMATIC GLASS (See Glass Feeders)

FELDSPAR
Sharp-Schurtz Co., Lancaster, O.

FIRE BRICK (See also Refractories)
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Dixon, H. L., Co., Box 140, Pittsburgh, Pa.
Laclede-Christy Clay Products Co., St. Louis, Mo.

FIRE AND FURNACE CLAY
Amsler-Morton Company, The, Pittsburgh, Pa
Dixon, H. L., Co., Box 140, Pittsburgh, Pa.
Laclede-Christy Clay Products Co., St. Louis, Mo.
Pittsburgh Plate Glass Co., Refractories Dept., Pittsburgh, Pa.

FLOATING AGITATORS
Amsler-Morton Company, The, Pittsburgh, Pa
Dixon, H. L. Co., Box 140, Pittsburgh, Pa.

FOUNDERS, GLASSHOUSE CASTINGS
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FURNACE ENGINEERS (See Engineering Service)

FURNACE INSULATION (See Insulating Brick)

FURNACE REPAIR MATERIALS
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Corhart Refractories Co., Louisville, Ky.
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Laclede-Christy Clay Products Co., St. Louis, Mo.
Pittsburgh Plate Glass Co., Refractories Dept., Pittsburgh, Pa.

FURNACES
Annealing (See Lehrs)
Tank and Pot
Amsler-Morton Company, The, Pittsburgh, Pa.
Dixon, H. L., Co., Box 140, Pittsburgh, Pa.
Recuperative
Amsler-Morton Company, The, Pittsburgh, Pa.
Toledo Engineering Co., Inc., Toledo, O.

GAS BURNERS
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Dixon, H. L., Co., Box 140, Pittsburgh, Pa.
Sharp-Schurtz Co., Lancaster, O.
Toledo Engineering Co., Inc., Toledo, O.

GAS MAINS, STEEL
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Dixon, H. L., Co., Box 140, Pittsburgh, Pa.

GAS PRODUCERS (See Producer Gas Plants)

GLASS CONSULTANTS
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Sharp-Schurtz Co., Lancaster, O.

GLASS FEEDERS, AUTOMATIC
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Hartford-Empire Co., Hartford, Conn.
Miller, Wm. J., Inc., Swissvale, Pa.

GLASSHOUSE CASTINGS (See Castings)

GLASSHOUSE MACHINERY AND EQUIPMENT (See also Glass Working Machinery)
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Hartford-Empire Co., Hartford, Conn.
Lynch Corporation, Anderson, Ind.
Wm. J. Miller, Inc., Swissvale, Pa.

GLASSHOUSE TOOLS
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Dixon, H. L., Co., Box 140, Pittsburgh, Pa.

GLASS PLANTS, COMPLETE INSTALLATIONS
Amsler-Morton Co., Pittsburgh, Pa.
Dixon, H. L., Co., Box 140, Pittsburgh, Pa.
Hartford-Empire Co., Hartford, Conn.

GLASS WORKING MACHINERY
Automatic and Semi-Automatic Bottle Blowing, Electric Presses, Feeders, etc.
Bailey & Sharp Co., Hamburg, N. Y.
Hartford-Empire Co., Hartford, Conn.
Lynch Corporation, Anderson, Ind.
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Muffle
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Wilson-Maeulen Pyrometer Division, The Foxboro Co., Foxboro, Mass.

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Laclede-Christy Clay Products Co., St. Louis, Mo.
Pittsburgh Plate Glass Co., Refractories Dept., Pittsburgh, Pa.

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Amsler-Morton Company, The, Pittsburgh, Pa.
Dixon, H. L., Co., Box 140, Pittsburgh, Pa.

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TANK BLOCKS
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Corhart Refractories Co., Louisville, Ky.
Dixon, H. L., Co., Box 140, Pittsburgh, Pa.
Laclede-Christy Clay Products Co., St. Louis, Mo.
Pittsburgh Plate Glass Co., Refractories Dept., Pittsburgh, Pa.

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